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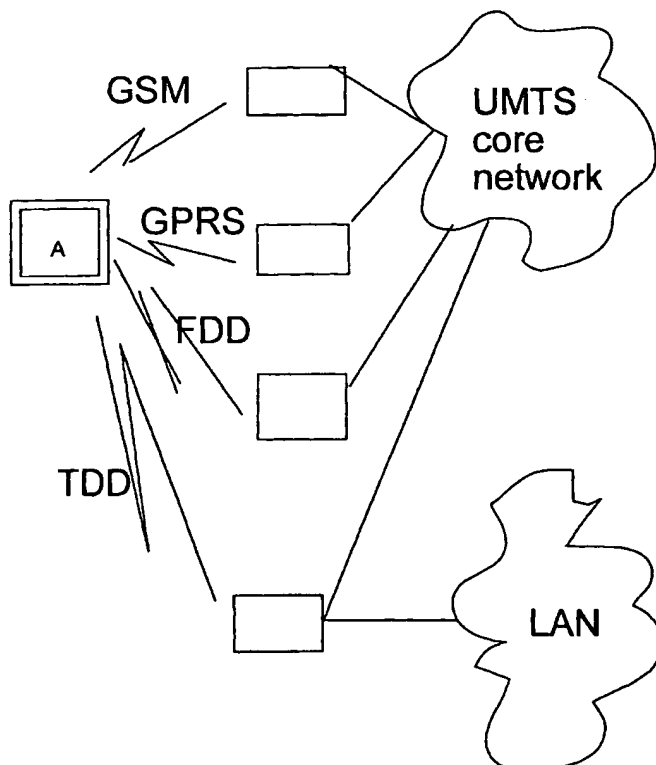
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(54) Title: METHOD FOR SELECTION OF RADIO NETWORK, AS WELL AS SYSTEM AND TERMINAL UTILIZING THE METHOD



(57) Abstract: The present invention relates to a method for selection of radio network when a terminal is allowed to select between a plurality of accessible radio networks. The terminal places the accessible radio networks in order of precedence and connects to the radio network which has been allocated highest priority. The radio networks are allowed to be of different kind, such as GSM, GPRS, WLAN etc. The terminal is allowed to communicate with the different radio network at which a priority list defines an order of preference between the networks. Selection of network is made by means of the priority list. When the terminal loses contact with the selected radio network the terminal checks whether contact with other radio network can be established. Further is checked whether network with higher priority than the utilized one is accessible. Connection is after that made to a network that has highest priority among the accessible networks.

## TITLE OF THE INVENTION

Method for selection of radio network, as well as system and terminal utilizing the method.

## 5 FIELD OF THE INVENTION

The present invention relates to a device and a method for a mobile multimode terminal in a UMTS-system where the terminal can use a plurality of different radio interfaces to get access to the user's UMTS-services within one and  
10 the same subscription of via different operators. The terminal is primarily supposed to be a data communication terminal which, however, also can be used for voice calls.

Brief about UMTS

15 UMTS (Universal Mobile Telecommunication Systems) is the name of mobile system of the third generation. The aim of UMTS is to complete existing mobile systems with in the first place multimedia services and data services with higher bit rate than the mobile systems of today. The real  
20 novelty of UMTS will be the radio interface, UTRAN (UMTS Terrestrial Radio Access) which makes use of new technology to provide high bit rates to the users, for instance from 364 kbit/s up to 2 Mbit/s. UMTS will be based on an evolution of the GSM-systems of today and tomorrow when the  
25 existing GSM-network (the 900 and 1800 band) is extended with GPRS and the radio interface of UMTS is connected to the "background" network of GPRS. The radio interface of UMTS will consist of one FDD-mode and one TDD-mode.

30 In the FDD-mode, all users will use the same frequency spectrum, but will be separated by means of codes, whereas in the TDD-mode a plurality of users will share one time slot by means of codes. The FDD-band will probably be licensed and the TDD-band not licensed. This results in  
35 that public UMTS-services will be offered via FDD-modems and that TDD-modems in the first place will be utilized for

private applications. There, however, exist operators who may have the intention to provide public applications also in TDD-modems.

5 UTRAN will in the first phase be extended in "covering islands" and be based on FDD-modems. By using GSM's radio access in areas where the covering has not yet been extended, the users can, multimode terminals provided, get access to the major part of their services, though with  
10 somewhat lower capacity, everywhere already from the beginning.

To make it possible for the user to make use of services in UMTS, it is required that a USIM-card, with identities and  
15 access information is available in the terminal. This USIM-card corresponds to the SIM-card, which today is utilized in GSM.

At connection of the terminals to the system, the mode  
20 which in the first hand shall be utilized shall be connected. However, there may at the connection be a plurality of connection alternatives, at which the mode which from different aspects is the most suitable shall be selected. Said aspects can on the one hand relate to which  
25 network said connection shall be made to, on the other which form of communication that shall be utilized at the intended communication. Further, there shall be surveillance regarding contact with the network to which connection has been made, as well as possibility to switch  
30 a communication in progress from one system to another network when the conditions for this is favorable. These matters have not been of current interest in existing radio communication networks, so the problems that now will arise at the introduction of the future UMTS-system has  
35 previously not been of current interest.

Further, there are need to in different ways prioritize in which order the different modes shall be connected, respective how the change between the different systems shall be performed with regard to different time intervals  
5 that shall be defined at different times.

#### PRIOR ART

In the mobile telephony there are at present a number of different communication systems utilized, where each system  
10 has its characteristics and protocols. These systems are normally not compatible with each other. The radio networks which at present are utilized imply that the mobile units which are utilized belong to respective system. Possibility to utilize a terminal, intended for communication in a  
15 system which is not in accordance with the protocol that is used in another system, is lacking. In the future UMTS-system, different basic functions are intended to be included in the system, at which the terminal shall have ability to connect to the system via different protocols  
20 and/or functionality. The terminal at that shall be possible to be utilized for connection to the different systems that are available. The different possible searches towards the system is in this connection described as different modes by which the terminal can connect to the  
25 system.

#### TECHNICAL PROBLEM

Different radio interface, for instance GSM, GPRS, UMTS FDD and UMTS TDD, will in the future cooperate to give the  
30 users access to their services everywhere. This means that the UMTS-terminal will be able to register (itself) in many different networks and at certain occasions there will be more than one possible network accessible. The present invention aims at solving the problem which occurs when the  
35 terminal shall select network in a radio environment with a plurality of different radio access networks accessible,

and when this environment is changed when the terminal,  
which is a mobile terminal, is moved.

New services which are introduced in UMTS will primarily be  
5 data services, so the invention will in the first place be  
utilized in connection with a data communication terminal,  
which is also intended to be utilized as voice terminal via  
for instance IP-telephony or circuit-switched GSM. The  
terminal shall for instance be able to operate towards the  
10 modes GSM, GPRS, UMTS FDD and UMTS TDD, i.e. the terminal  
has a number of different systems and radio interfaces to  
select from.

#### THE SOLUTION

15 The present invention relates to a method for selection of  
radio network when a terminal is allowed to select between  
a plurality of accessible radio networks. The terminal  
ranks the accessible radio networks and connects to that  
radio network which has been given highest priority. The  
20 radio networks are allowed to be of different kind, for  
instance GSM, GPRS, WLAN etc. The terminal is allowed to  
communicate with the different radio networks at which a  
priority list defines an order of precedence between the  
networks. Selection of network is made by means of the  
25 priority list. When the terminal loses contact with the  
selected radio network, the terminal checks whether contact  
with another radio network can be established. Further is  
checked whether network with higher priority than the  
utilized one is available. Connection is after that made to  
30 a network which has highest priority among the available  
networks.

The invention further relates to a system including a  
number of terminals which can be connected to accessible  
35 radio networks. At connection to a radio network the  
terminal selects the radio network which has been allocated

a highest priority. The terminal further adapts to a signaling system which is utilized by the selected radio network. Further, the terminals check whether contact with the selected radio network is maintained, and if network  
5 with higher priority is accessible. A check is also made as to whether a found radio network with higher priority than the utilized network is lasting or not. In a corresponding way is checked if loss of contact with the appointed radio network is permanent or not. In the terminals there also  
10 are means for identification of the different types of networks, at which the terminals can be adjusted between a number of the different types of networks. The radio networks are allowed to operate according to different principles such as GSM, GPRS, UMTS FDD, UMTS TDD etc. In  
15 the FDD-system, a number of terminals share one and the same frequency, at which the own information is distinguished by codes. In the TDD-system, a number of terminals share the same time slot where the information to respective terminal is identified by means of codes. To  
20 make it possible for the terminal to distinguish between the different radio networks, and to adjust itself, a USIM is utilized where there is information which both appoints the order of precedence between the radio networks and indicates which protocol that shall be utilized in  
25 respective network. At scanning of accessible radio networks a parameter, "n" , is utilized which is stepped, at which the value of the parameter appoints a specific radio network.

30 The appointment is made by means of a priority list. Parameter, n, takes a number of values corresponding to the number of networks that the terminal has possibilities to connect to. The priority list at that appoints the radio network in the order of priority that the terminal/user  
35 wants to utilize the networks. Further, the invention relates to a terminal to be utilized at selection of one of

several accessible radio networks. The terminal ranks radio networks and connects to that of the radio networks which has been given the highest rank. Within certain time intervals is checked whether radio network with higher rank than the utilized network is accessible. Further is checked whether the connection to the selected radio network is maintained or not. When network with higher priority is available, a check is made whether the found network has permanent contact with the terminal or not. Said contact is regarded to be permanent when the contact has had a duration the space of time of which exceeds a parameter the value of which has been appointed to x seconds. In a corresponding way is checked whether the contact with the selected network is maintained or not by, at interruption/break in the contact between the radio network and the terminal during periods longer than y seconds, the contact with said radio network is regarded as lost. At search for accessible radio network, a step mechanism is run through, the value of which appoints the accessible radio networks in the order of priority that is indicated in the priority list. The terminal further includes functions to adapt to the functionality and way of operation of the different radio networks, which information is indicated on an identity and access information card (USIM) in the terminal.

#### DESCRIPTION OF FIGURES

Figure 1 and 2 shows how a terminal can be utilized for communication between different radio networks.

Figure 3 shows a flow chart over the invention.

#### PREFERRED EMBODIMENT

##### Designations

GSM	Global System for Mobile Communications
UMTS	Universal Mobile Telecommunication System
UTRA	UMTS Terrestrial Radio Access

SIM           Subscriber Identity Module  
- TDD        Time Division Multiplex  
- FDD        Frequency Division Multiplex  
UTRAN        UMTS Terrestrial Radio Access Network  
5 USIM        UMTS Subscriber Identity

A user has a terminal by means of which he/she communicates via a number of different networks, such as GSM, UMTS etc. For the purpose the user's terminal is arranged to  
10 communicate with a number of different modes, i.e. the terminal contains functions which allow communication via different interfaces and radio networks. At call, the terminal checks which networks that are accessible and connects to the network which has been allocated highest  
15 priority. This priority is individual for the user and/or the terminal. Connection consequently is made to the network that best corresponds to the actual use. The user can utilize the terminal for different purposes, for instance voice or data communication. During the  
20 communication the terminal checks whether the connection to the network in question is intact or not. In case that the connection is not intact, a check is made whether the break is permanent or not. In the case that a temporary break is established, the selected network is retained in the  
25 continued communication. If, on the other hand, it is established that the contact with the selected radio network is permanently broken, the terminal scans accessible networks and establishes a connection to that of the accessible networks which has been allocated highest  
30 priority among accessible networks. During the communication in progress, the terminal continuously checks whether the connected network has highest priority or not.

If connection has been made to a network of lower priority,  
35 is checked whether network with higher priority is accessible or not. If there exists network with higher



priority, the terminal checks whether it has possibility to connect to a network of higher priority than the one that at present is utilized. If it is established that such a network is accessible and that the radio transmission is of sufficiently high quality, the connection is made to the new network in question over which the communication from then on is maintained until a network with higher priority is found, or that coverage for this network is lost and connection again is made to a network with lower priority.

10

In the following, the invention is described in connection with the flow chart in Figure 3. The description starts from the upper part of the flow chart where the terminal is supposed to be switched off, and at activation, switch on, of the terminal, a parameter, "n", is set to the value of 1. The parameter "n" appoints one to the parameter setting corresponding selection of mode. Said selection of mode is based on a priority list where different connections in one for the terminal established order has been defined. Said priority list can differ between different users, respective for different applications at the individual user. Setting up of the priority list can on the one hand be made by the user, and on the other by anyone who is responsible for the system. The parameter, "n", consequently appoints one of a plurality of possible connections, whereupon the terminal tries to connect to the appointed network. If contact with the network has not been made, is checked whether the parameter, "n", is larger than, or equal to, a parameter, "number", which indicates the number of possible selections of modes which are possible in the specific case. If the parameter, "n", is smaller than, "number", the parameter, "n", is stepped one step, whereupon a new selection of mode is made, and new attempts at searching is made. In the cases the parameter, "n", adopts a value which is larger than, or equal to,

35

"number", the parameter, "n", is restored to the value of 1.

After that, new attempts are made to get contact with any of the networks which are included in the subscriber's subscription, until contact has been established, or the  
5 subscriber stops the attempt to establish connection. When a network has been found, connection to said network is established and a parameter, "network", is set to the same value as the parameter, "n". After that, an indication is  
10 made that registration has been performed, whereupon a check is made whether the performed connection has been made to a network with highest priority or not. This is made by checking whether the parameter, "network", is equal to 1. If that is the case, a check is made again whether  
15 the terminal is still registered or not. In case that the reception conditions is approaching a lower limit, there is a waiting during a period of time corresponding to a parameter, "y", which is set to a value that shall be waited for before decision is made whether contact with the  
20 utilized network has been lost or not. Has the reception conditions not been changed or been improved, the system returns to recording the network as registered. If, on the other hand, it has been recorded that contact with the network has been lost, disconnection is made, whereupon a  
25 check is made whether parameter, "network", is different from 1, or not. If the parameter is equal to 1, said parameter, "n", is set to 1, otherwise to 2. After that, selection of mode is made as has been described above.

30 We will now return to the square "registered". When it is established that parameter, "network", is different from 1, parameter, "n", is set to 1, whereupon search for the network that has highest priority is made, and if this network is not accessible, it is checked whether the  
35 parameter, "n", is smaller than parameter, "network", and if that is the case, parameter, "n", is stepped forward one

step whereupon new search takes place. If no network is found, the algorithm is given the state "registered", after which a new search for network can be initiated.

- 5 In cases when network has been found, the system waits a period of time, "x", before check is made whether the found network is accessible or not. If network is not accessible, the system will return to the state "registered". In case that the found network is accessible, the used network is  
10 disconnected, whereupon set up of the found network is made and check proceeds as has been described above.

The user is further allowed to manually select the operator/network that shall be utilized. This selection can  
15 be made whenever the user so wishes.

The invention consequently consists of:

1. A network algorithm which describes how the terminal selects to which network it shall connects when it has  
20 possibility to lock itself to a plurality of networks. Further, the algorithm describes how the terminal shall function when it loses coverage from current network and how search for network with higher priority shall be made. The algorithm is shown in Figure 3.  
25
2. Priority lists according to which the terminal shall search for networks to register in. These lists can be determined by the user or by operators.
- 30 3. The possibility of a multimode terminal to listen for and identify a plurality of different systems with regard to quality and priority.

In the network selection algorithm two parameters "x" and  
35 "y" are used. These indicate periods of time the terminal shall wait before a change of network is made. These

periods of waiting shall be selected so that unnecessary signaling, as a consequence of that successive connections and disconnections are performed when the terminal is in the interface between two networks, is avoided. At  
5 selection of periods of waiting it is also important to observe that the terminal is not inaccessible for too long a period. Examples of suitable values are 5 seconds for the variable "x", respective 30 seconds for the variable "y". These periods of time can vary depending on the customer's  
10 and/or operator's wishes.

The way in which the terminal selects in which network it first it shall try to register can be made in three ways:

- 15 - according to a predefined priority list.
  - by the terminal first trying with latest utilized network
  - by manual selection
- 20 By means of the priority list the user or the operator can control which networks the terminal preferably shall register to. This list is implemented at the user's USIM-card. To facilitate for the user, a priority lists should be ready at the USIM-card when it is delivered to the user.

25

This list can be as below

- 1. TDD private
- 2. TDD public
- 3. FDD
- 30 4. GPRS
- 5. GSM

This order of preference gives for the operator the best utilization of the capacity in the networks and for most  
35 users the access with the best quality.

The user also can be given possibility to change in his/her priority list and have a number of different priority lists. Different priority lists can be useful if the USIM-card shall be used both in a data communication terminal  
5 and in a voice terminal, or if shall be used in different situations, for instance for private use or in the work. If a plurality of operators are involved, these of course can be arranged in the priority list according to wishes.

10 The operator or user may wish that the terminal in the first place shall register in the network where it latest was registered. In this case the terminal first tries to register there, but if this network is not accessible, it will search according to the alternatives in the priority  
15 list as is described below.

In certain situations the user may wish to control which network that shall be active, independent of priority. This may for instance be the case when the user wants to make a  
20 circuit switched call via GSM. This control also can be made indirectly by the user selecting a service which requires another network.

In the condition switched off the terminal is not active.  
25 When the terminal is started the process starts by register it in right network.

The automatic search and registration can be made either according to the predefined priority list, alternatively  
30 that the terminal first tries to register in the mode in which it latest was activated. If the latter is not possible, the priority list is used instead. The terminal searches for wanted network. It starts with the network that has highest priority, or in which it latest was  
35 registered. If the alternative "latest network" is used, the variable "n" is set to the number of this network in

the priority list. If it finds a network in which it can register, the search is finished. Otherwise it proceeds with next alternative in the priority list. The variable "n" used to move forward in the list. If no network has  
5 been found when the whole list has been gone through, the terminal starts from the beginning and scans the list.

When the terminal has found a network which is accessible and in which the terminal can register, connection is  
10 established to this network. The variable "network" adopts the value of the variable "n" which is the priority number of the active network.

The normal state/condition of the terminal is registered  
15 when it is in active state and it is registered in the selected network. The terminal will be in this state/condition until any of the following events occur:

- a network with higher priority is found
  - 20 - the terminal loses coverage
  - the user makes a manual selection of mode (either actively or by selecting a service which requires another network).
- 25 Search for network with higher priority is made when the terminal is in a network which does not have highest priority. This is made when the terminal is registered with certain intervals where the terminal first establishes that it is not already registered in the highest prioritized  
30 network. In this case the terminal returns to the state registered. If not, it makes a search of the networks that have higher priority. In no such network is found, the terminal returns to the state registered. If network with higher priority is found, the terminal waits a period of  
35 time "x" before further measures are taken. This in order

to make sure that the reception from the new network is not temporary.

If the new network still is accessible after the period of  
5 time "x", a disconnection is made of the previous network  
and a setup of the new network is made. The terminal after  
that returns to the state registered, now in the new  
network.

10 In case that the new network is not accessible after the  
period of time "x", the terminal returns to the state  
registered.

At disconnection, disconnection is made of network in  
15 question.

If the terminal loses coverage, by the signal strength from  
the network in question falling below one by the operator  
defined lowest level, the following will happen.

20 If the terminal loses coverage from the network in which it  
is registered, it shall wait the period of time "y" before  
measures are taken. This to make sure that the decrease of  
the signal strength is not temporary. If the network in  
25 question is accessible again after the period of time "y",  
the terminal returns to the state registered. If not, a  
disconnection is made of the network in question and the  
terminal starts scanning/searching for a new network as has  
been described above.

30 The invention is not limited by the patent claims below,  
but can be subject to modifications within the frame of the  
idea of invention.

## PATENT CLAIMS

1. Method for selection of radio network, where a terminal (A) is allowed to select one of a plurality of accessible radio networks, characterized in that the terminal ranks the accessible radio networks, that the terminal selects to connect to the radio network that has been allocated highest priority.
2. Method as claimed in patent claim 1, characterized in that the radio networks are of different types, such as GSM, GPRS or WLAN.
3. Method as claimed in patent claim 2, characterized in that the terminal is allowed to communicate with the different networks.
4. Method as claimed in any of the previous patent claims, characterized in that the terminal has been allocated a priority list defining an order of preference between the networks.
5. Method as claimed in any of the previous patent claims, characterized in that the terminal searches/scans accessible networks by means of the priority list.
6. Method as claimed in any of the previous patent claims, characterized in that the terminal at lost contact searches connection with any of the remaining networks.
7. Method as claimed in any of the previous patent claims, characterized in that the terminal checks whether network with higher priority is accessible.



8. Method as claimed in any of the previous patent claims, characterized in that the terminal selects to connect to the network that has highest priority.

5 9. Method as claimed in any of the previous patent claims, characterized in that the network which has highest order of preference is selected.

10. System, including a number of radio networks and  
10 terminals which can be connected to the radio networks, characterized in that the terminals, at connection to the radio networks, selects that of the radio networks which has been allocated a highest priority, and that the terminal adapts to a signal system which is  
15 utilized by the selected radio network.

11. System as claimed in patent claim 10, characterized in that the terminals on the one hand checks whether contact with the selected radio network  
20 is maintained, and on the other whether network with higher priority than the selected is accessible.

12. System as claimed in patent claim 11, characterized in that check is made whether  
25 contact with radio network with higher priority is permanent or not, respective whether loss of radio network is permanent or not.

13. System as claimed in patent claim 12,  
30 characterized in that the radio networks operate according to different principles such as GSM, GPRS, UMTS FDD and UMTS TDD.

14. System as claimed in patent claim 12,  
35 characterized in that the terminals include means for identification of the different type of networks,

at which the terminal is adjustable between a number of the different types of networks.

15. System as claimed in patent claim 13,  
5 c h a r a c t e r i z e d in that in radio systems  
utilizing FDD a plurality of terminals share one frequency  
at which the separate terminals identify themselves by  
means of codes, respective that in radio systems according  
to TDD a plurality of terminals share one time slot and  
10 that information to respective terminal is identified by  
codes.

16. System as claimed in any of the patent claims 10-15,  
c h a r a c t e r i z e d in that the terminal includes a  
15 control device (USIM-card) which appoints the radio  
networks which are allowed to be utilized and an order of  
preference that shall be applied at selection of radio  
network.

20 17. System as claimed in any of the patent claims 10-16,  
c h a r a c t e r i z e d in that a parameter, n in the  
terminal is stepped forward, that parameter, n, appoints  
the radio networks in an order of priority which is  
determined in the priority list, that the parameter, n,  
25 runs through a number of values corresponding to the number  
of radio networks that the terminal is allowed to be  
connected to.

18. System as claimed in any of the patent claims 10-17,  
30 c h a r a c t e r i z e d in that the priority list  
appoints the radio networks in the order these shall be  
utilized, and that the value of the parameter, n, indicates  
a position in the priority list which indicates the  
appointed radio network.

19. Terminal utilized at selection of one of a plurality of accessible radio networks, characterized in that the terminal places the radio networks in order of precedence, that connection is made to that of the radio networks that has been allocated highest priority.

20. Terminal as claimed in patent claim 19, characterized in that the terminal within a determined time interval on the one hand checks whether radio network with higher priority than the utilized one is accessible, on the other checks whether the connection to the selected radio network is intact or not.

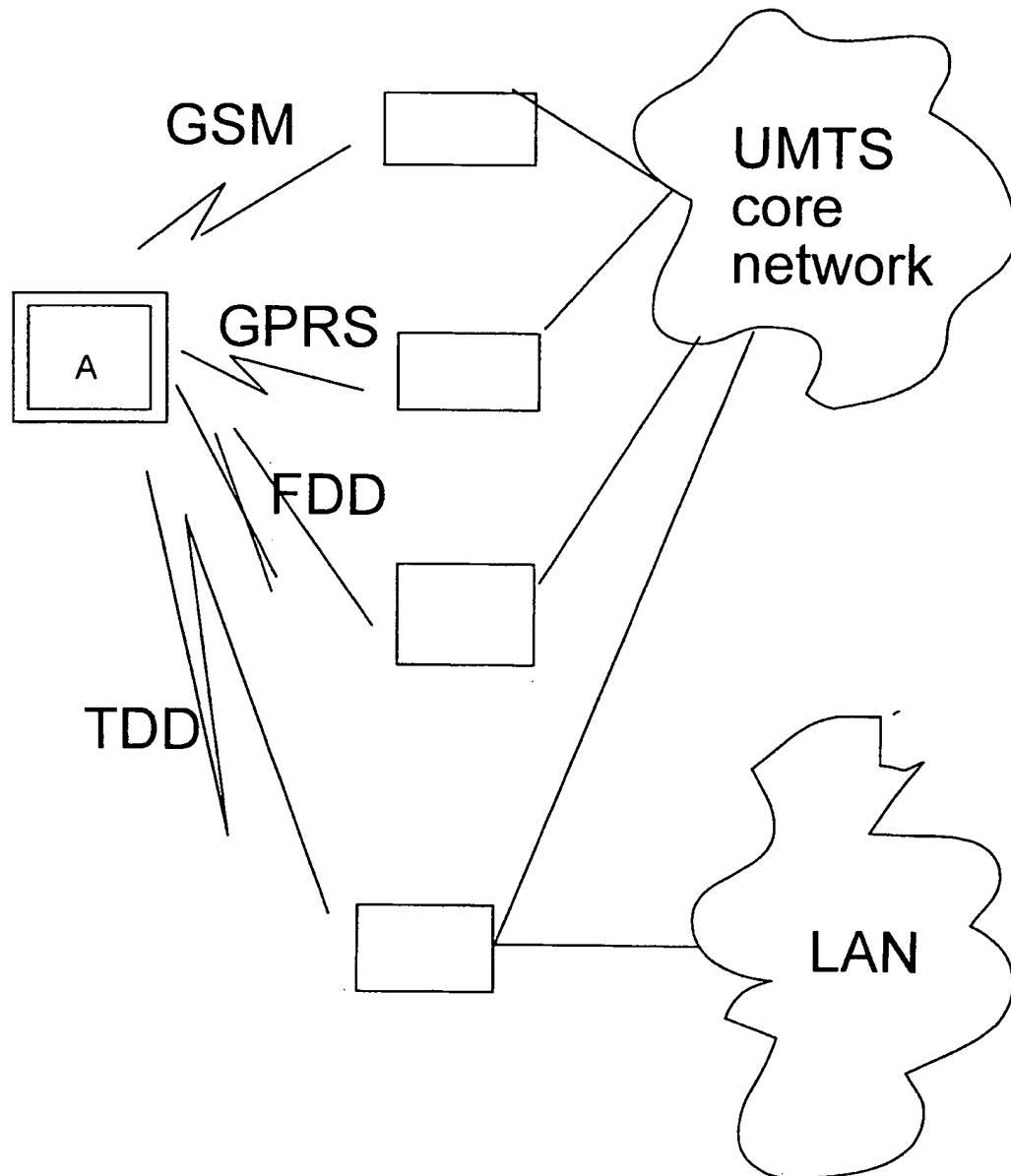
21. Terminal as claimed in patent claim 20, characterized in that, at establishing of that network with higher priority is accessible, check is made whether the contact is permanent or not, and/or that at loss of contact with the utilized radio network check is made whether the contact is permanently lost or not.

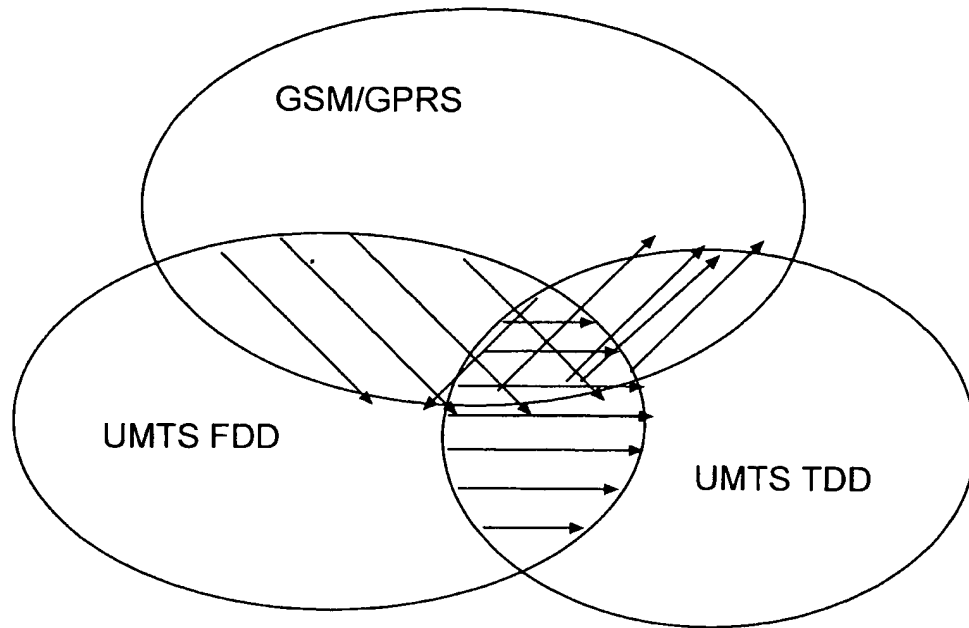
22. Terminal as claimed in patent claim 21, characterized in that permanent contact with an appointed network has been established when the contact has a duration exceeding a parameter the value of which is set to x seconds, and loss of contact with that radio network is established when the contact has been broken for a period/duration of more than y seconds.

23. Terminal as claimed in any of the patent claims 19-22, characterized in that the terminal at search for accessible radio network runs through the step mechanism the value of which appoints the accessible radio networks in an order or priority which is indicated in a priority list.

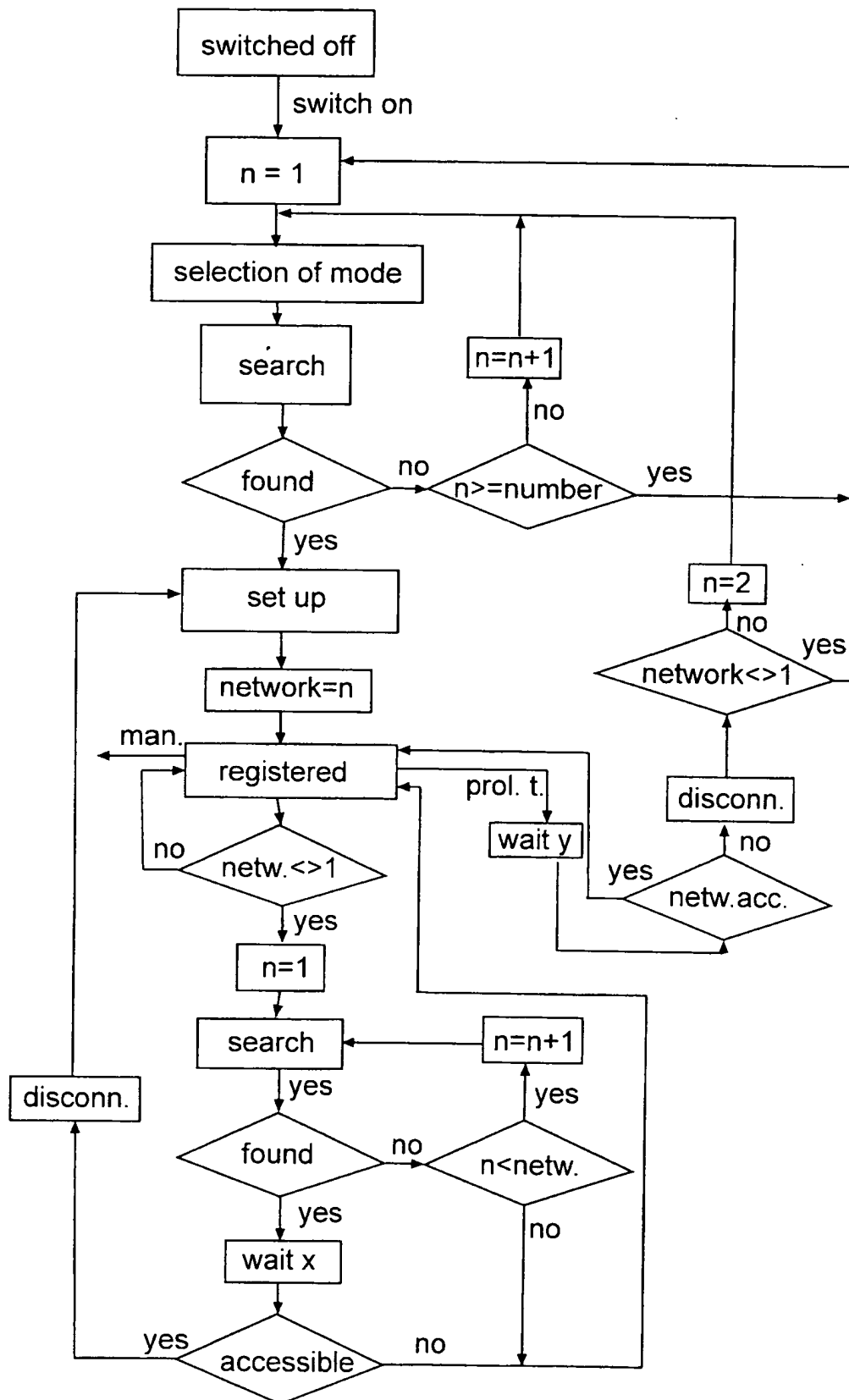
24. Terminal as claimed in any of the patent claim 19-23,

c h a r a c t e r i z e d in that the terminal includes  
functions to adapt to the functionality and ways of  
operation of the different radio networks, which  
information is indicated on an identity and access  
5 information card (USIM) in the terminal.

**Figure 1**



**Figure 2**

**Figure 3**

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/00188

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/32, H04Q 7/38

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 0980190 A1 (ROBERT BOSCH GMBH), 16 February 2000 (16.02.00), page 5, line 39 - page 6, line 18, abstract  --	1-24
X	EP 0781064 A2 (NOKIA MOBILE PHONES LTD), 25 June 1997 (25.06.97), column 8, line 13 - line 41; column 9, line 24 - line 33, abstract  --	1-24
X	EP 0899977 A1 (KONINKLIJKE PHILIPS ELECTRONICS N.V.), 3 March 1999 (03.03.99), column 1, line 50 - column 2, line 7, abstract  --	1-24

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/00188

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30/04/01

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